

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 510

Onshore Structure - Design

02	12/2018	General review
01	12/2017	General update due to harmonization with RC and MS
00	11/2015	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/IP/TEC	Managing entity: DSO/IP/TEC/STR
Other Approving entity(ies):	

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1. Scope

This general specification is to specify the minimum requirements for the design and sizing of steel and concrete structures for onshore facilities, including foundations.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Where there are national regulations, their particular requirements, and those of the standards or codes to which they refer, shall be applied, supplementing or amending the provisions of this document.

If there are no mandatory national regulations, standards and codes shall be chosen from those listed below according to the projects in hand. The list of regulations, standards and codes to be used shall be proposed by the Contractor and approved by Company.

If certain points in these regulations need to be clarified, the Contractor shall describe and justify the changes and/or additions to be made so that they can be adapted to the nature and environment of the project. Such proposals shall be considered acceptable only when they have been examined and approved by the Company.

Only the main standards are mentioned in the list below; the Contractor shall be responsible for compliance with any secondary standards or national annexes. The list provided in this document should not be regarded as exhaustive.

In this document, Euronorms and Eurocodes are the basement but Contractor may propose other corpus of Codes and Standards.

In the absence of a specific exemption, duly justified by the Contractor and agreed by the Company, codes and standards of different origins shall not be used in whole or in part.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ACI 318 (All parts)	Building code requirements for structural concrete and commentary - All parts
ACI 350 (All parts)	Environmental engineering concrete structures - All parts
AISC 325	Steel construction manual
ANSI/AISC 360	Specification for structural steel buildings
ASCE 7	Minimum design loads and associated criteria for buildings and other structures
EN 1090-2	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures
EN 13084-1	Free-standing chimneys - Part 1: General requirements

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Reference	Title
EN 14620 (All parts)	Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperature between 0°C and -165°C - All parts
EN 1990	Eurocode - Basis of structural design
EN 1991 (Parts 1; 3; 4)	Eurocode 1 - Actions on structures - Parts 1; 3; 4
EN 1992 (Parts 1; 3)	Eurocode 2 - Design of concrete structures - Parts 1; 3
EN 1993 (Parts 1-1; 1-2; 1-8)	Eurocode 3 - Design of steel structures - Parts 1-1; 1-2; 1-8
EN 1998-1	Eurocode 8 - Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings
ISO 14122 (Parts 2; 3)	Safety of machinery - Permanent means of access to machinery - Parts 2; 3

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP CIV 300	Reinforced and prestressed concrete - execution
GS EP CIV 401	Minimum requirements for building design and construction
GS EP CIV 500	Foundations for onshore structures
GS EP GEO 102	Onshore Geotechnical Investigation
GS EP GEO 501	Meteorological and Oceanographic survey
GS EP GEO 602	Seismic Hazard Assessment for Onshore Structures
GS EP POS 003	Land surveying and positioning works
GS EP STR 500	Onshore Structure - General
GS EP STR 520	Onshore Steel Structure - Material and Fabrication
GS EP STR 901	Design rules and construction standards for ancillary structures of offshore installations
GS EP STR 710	Onshore Blast Resistant Buildings

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3. Applicability

This specification is applicable to the following engineering tasks:

- Preliminary and basic design
- Development of project particular specifications
- Detailed design
- Expertise.

4. Definitions of terms

For the purpose of this document, the following terms and definitions apply:

Company: Any entity of the TOTAL group mentioned in the contract or the order.

Engineering Company: Individual or company providing, according to this specification, the following services:

- Basic studies and possibly detailed studies
- Potential procurement of material
- Placement of work orders.

The Engineering Company may be the Contractor or Company.

OBE: Operating Basis Earthquake

PGA: Peak Ground Acceleration

SLS: Serviceability limit states

SSE: Safe Shutdown Earthquake

ULS: Ultimate limit states

5. Site and Project data

5.1 Site safety rules

From the site safety rules provided by Company at the beginning of the project, the Engineering Company shall identify those impacting the design and sizing of structures.

These rules can be related to structural design (e.g. taking into account the earthquake), the conditions of works (e.g. underground investigations by manual means or prohibited use of certain types of work engines with unit in operation), etc.

5.2 Project Safety Requirements

From the project safety requirements provided by Company at the beginning of the project or part of the engineering scope of works, the Engineering Company shall identify those impacting the design and sizing of structures.

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Fire and blast studies may drive designs and requirements of structures and buildings. **GS EP STR 710** shall be used to design in that case.

5.3 Summary of site data

Site conditions shall include all relevant information for the design and sizing of structures:

- Elevation of the site.
- Climatic conditions identified (mean and range) and values used in the calculations:
 - Ambient temperature
 - Ambient humidity
 - Wind (climatic region, basic velocity, wind direction, seasonal factor, terrain roughness)
 - Snow (climatic region, loads of normal and accident snow)
 - Rainfall (normal and accidental water flow rates)
 - Severity of frost and frost depth.
- Geological and geotechnical characteristics of the soil.
- Levels of groundwater.
- Exposure to earthquake (seismic zone classification, ground type and spectra).
- Ambient corrosivity:
 - Air
 - Soil and groundwaters.
- Potential marine atmosphere (exposure to salt spray, brackish waters).
- Altimetric and planimetric reference systems.

If site conditions must be defined through specific studies:

- Geotechnical investigations shall comply with **GS EP GEO 102**
- Seismic hazard assessment shall comply with **GS EP GEO 602**
- Topographical surveys shall comply with **GS EP POS 003**
- Meteorological surveys shall comply with **GS EP GEO 501**.

5.4 Geological, geotechnical and environmental data

The Engineering Company shall collect all the data needed to determine:

- Conditions of excavation, earthworks and soil compaction
- Deep foundations
- Shallow foundations
- Conditions for possible improvement of soil
- Groundwater levels

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- Potential risks of soil liquefaction
- Environmental quality of soil to be removed
- Conditions of soil-structure interaction for possible dynamic calculations.

At the stage of the preliminary design, this information can be provided by Company from existing investigations and geological, geotechnical and environmental studies but, if necessary, collected on the occasion of the project.

The Engineering Company shall not accept any recommendation of reports submitted without previous critical analysis. Any conclusion drawn from these reports is the sole responsibility of the Engineering Company.

At the beginning of the project and during the project if necessary, the Engineering Company shall perform all necessary geotechnical studies. These shall be conducted in accordance with specification **GS EP GEO 102**.

5.5 Structure design working life

Generally, structures other than temporary structures shall be designed for a working life of 50 years corresponding to the category 4 of design working life as defined in **EN 1990**. The design of individual components of the facilities may include a strategy for planned obsolescence and replacement, where a single equipment lifetime of 50 years is not feasible or optimum. In instances where such a replacement philosophy is adopted, the initial design shall include demonstration of how replacement will be optimally achieved.

For temporary or "exceptional" structures (e.g. tank foundations), the working life and the associated category shall be defined with Company.

5.6 Survey references for structure lay-out

If it does not already exist, a reference level shall be adopted for the considered project (such as the high point of the pavement). On each drawing, a note shall indicate the correspondence between the reference level and the altimetry system used on the site.

If it does not already exist, a topographic monument shall be created to serve as a reference for altimetric and planimetric surveys. This monument shall be fixed, permanent (at least for the duration of the project), clearly identified, far enough away from traffic and activity areas, protected against possible shocks, insensitive to settlements. The location of the monument shall be approved by Company. The position and the level of the monument shall be checked monthly. Any deviation shall be reported to Company.

In addition, when stipulated in the contract, a topographical survey carried out by a surveyor shall be established.

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6. Actions on structures

6.1 General

6.1.1 Definition of actions

According to [EN 1990](#), the actions (F) on the structures consist of:

1. Forces (or loads) applied to the structure (direct actions)
2. Forced strains or accelerations caused for example, by temperature changes, moisture variation, uneven settlement or earthquakes (indirect actions).

6.1.2 Applicable standards

Actions on structures shall be calculated according to the Eurocodes, in particular the following standards and their national implementation annexes [EN 1991-1-1](#), [EN 1991-1-2](#), [EN 1991-1-3](#), [EN 1991-1-4](#), [EN 1991-1-5](#), [EN 1991-1-6](#), [EN 1991-1-7](#), [EN 1991-3](#) and [EN 1991-4](#).

Alternatively, actions on structures can be calculated according to other corpus of Codes (see chapter 2) such as [ASCE 7](#).

Use of other standards shall be approved by Company.

6.1.3 Classification of actions

Actions on structures shall be classified according to their application times and their changes over time:

- Permanent actions (G): Action that is likely to act throughout the working life of structure and for which the variation in magnitude with time is negligible (e.g. self-weight of structures and equipment, indirect actions caused by concrete shrinkage and differential settlements).
- Variable actions (Q): Action for which the variation in magnitude with time is negligible (e.g. operating and maintenance loads).
- Accidental actions (A): Action, usually short but of significant magnitude, which is unlikely to occur on a given structure (e.g. fire and explosion).
- Seismic actions (A_E): Action considered accidental with particular calculation rules.

Actions due to water shall be considered permanent or variable, depending on their variation in magnitude with time.

The classification of selected actions shall be subject to a common agreement between Engineering Company and Company.

6.1.4 Estimated loads for preliminary design

Assuming that data could not be collected quickly enough, the Engineering Company may, with Company agreement and according to its own appraisal, use one or more sets of assumptions which allow simulating the behaviour of the structure. These assumptions are valid only in the preliminary design phase.

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6.2 Permanent actions (G)

6.2.1 Permanent loads on structures (equipment weights excluded)

Permanent loads on structures (weight of equipment excluded) shall be calculated according to [EN 1991-1-1](#) and related national annex. These loads are as follows:

- Self-weight of structures, including the weight of foundations
- Weight of the appliances, materials and non-structural loads, supported directly by the structures (handling devices permanently attached, electrical and instrumentation equipment, cable trays, platforms, walkways, stairs, ladders, fire protection, partition, etc.).

6.2.2 Weight of equipment and piping

According to design situations, it shall be taken into account:

- Erection dead load:
 - Fabricated weight of vessels, machinery and piping, the same as weight of tanks and piping during their erection on-site.
- Empty dead load:
 - Erection dead load
 - Weight of accessories (fixed and removable) and overloads, directly supported by the equipment (internal, tracing, insulation, protection against fire, valves, pipes, cable trays, walkways, ladders, etc.).
- Operating dead weight:
 - Empty dead load
 - Weight of their contents (process fluids, catalysts, stored products, utility fluids, etc.) in normal operating condition.
- Test dead load:
 - Empty dead load
 - Weight of the medium used for the pressure tests.

When several independent equipment are supported on the same structure or on the same foundation, they are supposed to be tested individually.

6.2.3 Other permanent actions

- Weight and earth pressure on the foundation.
- Hydrostatic thrust or potential uplifts due to groundwater.
- Indirect actions such as the effects induced by concrete shrinkage, differential settlements or negative friction on piles.

6.3 Live loads (Q)

Live loads on structures cover all actions induced by use and occupancy thereof.

They include the weight of all mobile and temporary loads including:

- The weight of the personnel and their tools
- The weight of products, materials, equipment and miscellaneous pieces of equipment that are stored or dismantled momentarily.

The following table gives the minimum values that shall be applied to current structures except buildings that are addressed in **GS EP CIV 401**.

Type of element	Distributed loads	Concentrated loads
Floors and platforms for light storage, operation and maintenance (including platforms attached to equipment) • Main structural members (beams, columns) • Plating and grating with their supporting beams	2.5 kN/m ² 5.0 kN/m ² (1)	1.5 kN (2) (3)
Floors and platforms for heavy storage (including platforms attached to equipment)	To be defined by the Engineering Company with Company approval	
Landings on flares and flue gas stacks	1,5 kN/m ²	
Landings on flares and flue gas stacks	1.5 kN/m ²	
Roofs • Inaccessible roofs (except for normal maint.) • Accessible roofs	1.0 kN/m ² 2.5 kN/m ²	1.5 kN (2) (4)
Means of access (walkways, stairs and landings)	2.5 kN/m ²	1.5 kN (2) (3)
Notes: (1) To take account of local accumulation of loads on the decks. (2) The check under concentrated loads is complementary to the check under uniformly distributed loads. The two types of loads are not cumulative. Concentrated loads are to be applied to the location where the effect is maximal. (3) Concentrated loads applied to a surface of 200 x 200 mm according to ISO 14122-2. (4) Concentrated loads applied according to EN 1991-1-1. (5) Concentrated loads applied according to ISO 14122-3.		

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6.4 Environmental Action (E)

6.4.1 Wind actions (E_w)

Wind actions shall be calculated according to [EN 1991-1-4](#) and the associated national annex. The following assumptions shall be taken into account in the calculation of the force exerted by the wind:

- Open Structures:
 - The effects of wind on each element of the structure and on the equipment supported by the structure shall be added.
- Towers, drums, tanks or equipment of similar geometry:
 - The dynamic pressure shall be applied to the whole reference area wrapping equipment and ancillary components (insulation, pipes, walkways, ladders and other accessories). At the stage of preliminary design, the reference area can be taken to be 120% of the reference area proper to equipment, thus taken into account the diameter of equipment multiplied by 1.2.
- Pipe tiers on pipe racks:
 - The reference area A_{ref} to calculate the force exerted by the wind on a span can be determined by first approach according to the table below with:
 - . W =width of the bent
 - . L = bent spacing

Crosswinds	Longitudinal wind	
For each tier: $A_{ref} = L.(D + 0,1.W)$ D = larger pipe diameter (insulation included) with a minimum of 200 mm	Horizontal(s) tier(s): $A_{ref} = W.\beta.L$ $\beta = 0,10$ for 1 tier $\beta = 0,05$ for 2 tiers or more	Vertical piping: $A_{ref} = S_p$ S_p = exposed surface of piping

6.4.2 Snow loads and Ice loads (E_s)

Snow loads shall be calculated according to [EN 1991-1-3](#) and national implementation annexes or dedicated values from Meteo Project Assessment.

Snow or ice loads on piping shall be considered if geographical considerations justify it.

When geographical considerations justify it, ice loads shall be calculated following to [GS EP GEO 501](#) results and recommendations.

The induce vibration phenomena shall be evaluated with the presence of ice on the structure. The two (2) first modes of the structure shall be compared with the vibration frequencies that could be expected from model and/or physical tests (in situ and/or in laboratory).